that astronomical observers will probably be able to make a definite decision as to whether or not any of the existing spiral nebulae have developed from bacula or from less regular forms by substantially the same method. Till that is decided further discussion would be superfluous. It is possible that there are well developed spiral nebulae in which mutual interference has done little or nothing to reduce orbits to ellipses of small eccentricity. To such nebulae the analysis here indicated has no application, nor could their motions be formulated in the present state of science.[9]

[1] *Amer. J. Sci.*, Ser. 4, **5**, 102 (1898).

[2] Chapter VI, p. 482, of the edition of 1835.

[3] *Amer. J. Sci.*, Ser. 4, **5**, 106–107 (1898).

[4] See preface to *Worlds in the Making*, 1908.

[5] *Paris, C. R. Acad. Sci.*, **158**, 1017 (1914); and *Astrophys. J.*, **40**, 241 (1914).

[6] *Pop. Astr.*, **23**, 485 (1915).

[7] A. G. Webster, *Dynamics of Particles*, etc., 2d ed., 1912, p. 317.

[8] From a photograph taken at the Yerkes Observatory.

[9] Just in time for a reference, I have met with an interesting paper by Mr. E. J. Wilczynski, *Astrophys. J.*, **4**, 97, (1896), who pointed out that, if circular orbits are assumed, every long streak of nebulous matter must eventually be converted into a spiral as a consequence of Kepler's third law. The equation of this curve, he says, it would be easy to deduce.

A PECULIAR CLAY FROM NEAR THE CITY OF MEXICO

By E. W. Hilgard

UNIVERSITY OF CALIFORNIA

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In 1912 Dr. George W. Shaw, then connected with the College of Agriculture of the University of California, was requested to visit the Hacienda Santa Lucia, in the neighborhood of the City of Mexico, in order to give advice for the reclamation of certain tracts of land which were supposed to be afflicted with 'alkali,' and which had resisted the usual methods for rendering them productive. Dr. Shaw brought back samples of the soils from these alkali spots, which were as usual depressed in the middle, but found in them no excessive amounts of carbonate of soda, and that the sulphate (Glaubers salt) was mainly present in fractions of one per cent, not enough to injure vegetation.

In an attempt to leach one sample of its soluble salts he found that on pouring water on a few grams placed in a 50 cc. cylinder the substance swelled very rapidly, and over-night actually filled the cylinder to the top, making a semifluid slush. As I had never seen the like before, I undertook to investigate it.

The material, looking like an ordinary dark gray clay, adhered strongly to the tongue, and with a little water became very plastic. Unfortunately the main sample collected by Dr. Shaw came to the laboratory unlabeled and was by mistake thrown away by an assistant. A small sample of about 24 grams, however, was left; and on this the entire investigation had to be made. About half of this sample was boiled in distilled water for 24 hours for sedimentation, as there were some coarse particles, apparently of talcose schist. A reference to geological descriptions of the basin of Mexico, in which serpentines and talcose rocks are prevalent, seemed to confirm this conclusion.

The suspension did not appear to be very uniform even after protracted boiling, and under the microscope showed a multitude of dark rounded particles, very uniformly distributed through a colloidal medium of faintly yellowish tint, which when colored with a solution of 'malachite green' merely showed the fine discrete particles in larger numbers and greater fineness.

All attempts to free the colloidal ingredients from the visibly discrete particles by sedimentation proved futile. The suspension was readily coagulated and precipitated, apparently unchanged, by a solution of sodium chloride. On washing by decantation the suspension was again readily made, the microscopic character also remaining the same.

As the original material effervesced somewhat with hydrochloric acid it was conjectured that the minute grains might be earth carbonates; but the addition of drops of tenth-normal acid was slow in producing coagulation, doubtless on account of the neutralization of the acid by the earth carbonates. The filtrate gave reactions of calcium and more strongly of magnesium; yet the coagulum itself seemed to contain as many discrete particles as before, showing that the earth carbonates were very finely distributed, and not visible.

For the determination of the specific gravity some pure selected fragments weighing 1.073 grams were dried in a 25 cc. bottle. Filling the bottle, 0.481 gram of water was found to have been displaced, making the specific gravity about 2.25, nearly that of kaolinite clays. The substance was left in the gravity bottle until, with the aid of slight heating, it had absorbed the maximum amount of water, leaving a clear remainder above it. The water poured off measured 14 cc., showing that 11 cc. had been taken up by the clay, forming a coherent, gelatinous-looking mass, and giving an increase of bulk equal to about 25 times the volume of the clay. The mass was then evaporated to dryness in an air bath, with suction, at about 50°C., in order to avoid a possible molecular change; the bottle then was refilled with water. The reabsorption took place

more slowly than with the crude substance, and although aided by heating to 100° for three days, did not recover the full volume of 11 cc.

A repetition of the experiment with 1.70 grams of dry clay which had been precipitated from diffusion by ammonium carbonate, gave an increase of volume to 32 times that of the clay.

A parallel experiment with some ordinary plastic clays showed an increase of only two to two and a half times the original bulk.

Chemical Composition of the Clay.—On leaching the original substance with water, it was found to contain 2.60 % of soluble salts, of which 1.74 was sodium sulphate, 0.74 sodium carbonate, and 0.12 sodium chloride. Black rings from the evaporation of the alkali solution were reported to exist in the depressed spots, as is usual in the case of 'black alkali.'

In attempting to obtain for analysis a sample free from carbonates, it was found that silica went into solution even when only cold tenth-normal acid was used. It was therefore necessary to analyze the entire mass. On ignition the loss was 19.6 %; the ignited material decrepitated when wetted, but did not swell.

Two analyses of the original material were made; one by acid digestion for five days; another, after ignition, by fusion with alkali carbonate. Unfortunately the material at command was too scanty to permit the use of more than one gram and 1.7 grams for these analyses, respectively, the results being as follows:

Partial Analyses of Clay from Mexico.

	Acid digestion.	Fusion with carbonate of soda. (Ignited substance)
Insoluble	1.83%	0.00
Soluble silica	43.00	51.43
Lime	9.06	8.97
Magnesia	17.11	27.07
Ferric oxid	1.76	10.63
Alumina	3.48	
Ignition loss (water, carbonic acid and organic matter)	19.60	0.00
Soluble salts	2.60	
Total	98.44	98.10

The above data, deficient as they are, show clearly a totally different composition from any 'clay' on record. The alumina present is far below any reasonably assumable compound with the soluble silica; the predominant base being evidently magnesia, and that greatly in excess of the lime present. There is thus an apparent relationship to the saponite or sepiolite group of minerals, but the extremely ready decomposition by acids (even by acetic acid in dilute solution) differentiates

the material pointedly from that group, even apart from the exceptionally high absorptive power for water. I believe that what has been shown is sufficient to characterize a new kind of clay with a predominant magnesium instead of aluminum base, for which I suggest the name of *Lucianite,* from the locality where it was found. A better name, Auxite, referring to the exceptional increase in bulk, is too similar in sound to Augite to be desirable.

Wishing to obtain, if possible, additional material from the Mexican locality, I wrote to Don Jose G. Aguilera, the Director of the Instituto Geologico de Mexico, at the City of Mexico, transmitting also a blueprint map on which Dr. Shaw had marked the several localities from which he took samples. Dr. Aguilera very promptly and courteously responded to the request, despite the disturbed condition of the country (in 1912). Dr. Aguilera also sent statements of the analyses of clay materials from the foundations of the Legislative Palace, when building in 1904. These also show a large predominance of magnesia in the substrata of Mexico City.

The samples received, all from low 'alkali spots' in the Hacienda, resembled in general aspect the material brought by Dr. Shaw, but contained more coarse materials, among which talcose schist and black eruptive rock were readily discernable. The fine portions all showed exceptionally high expansion when wetted, one going as high as 12 times the bulk of the raw, dry mass. It was then attempted to obtain from this sample by sedimentation a clay of higher absorptive power. But the highest result so obtained was only 16 times the original bulk. Qualitative tests of this material showed again a large proportion of calcium and magnesium carbonates, with only small amounts of alumina and ferric oxide. The microscopic characters were the same as before noted in the original material, and there was the same easy decomposition of the silicate present with even weak acids, which stands in the way of obtaining a substance of definite and constant composition, free from earth carbonates.

As regards the reclamation of these alkali spots it is obvious that it cannot be accomplished by liming, as a large amount of calcium carbonate is already present and yet does not prevent the collapse of the colloidal ingredient in drying. The depressed spots probably become nearly level during the rainy season by the expansion of the colloidal ingredient. It seems as though acid treatment, instead of that with lime, were the only possible effective agent.

Circumstances have prevented a further prosecution of this investigation, which will be resumed whenever possible. Meanwhile it may be

fruitful to suggest the possible practical use of these magnesian clays in cases in which a tight tamping is necessary where water has access, as in shutting off crevices in bored wells when, as in those yielding oil, undesirable flows of water interfere, and where tamping with ordinary clays fails to tighten sufficiently and permanently. Other uses for such a prodigiously swelling material readily suggest themselves.

STUDIES OF MAGNITUDES IN STAR CLUSTERS, I. ON THE ABSORPTION OF LIGHT IN SPACE

By Harlow Shapley

MOUNT WILSON SOLAR OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

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All researches on the structure of the stellar universe must take into account the probable and possible effects of the scattering or obstruction of light in its passage through interstellar space. It is recognized, for instance, that if the loss due to absorption, or scattering, by the free molecules of matter in space totals as much as a millionth of one per cent of the visual light in a journey of a hundred million miles, then, assuming the effect proportional to the distance, every star 3500 light-years away would be observed about two magnitudes fainter than its true brightness. As a consequence any uncertainty in the coefficient of scattering, especially if it is large as cited above, is very serious in studies of the distance of the faint stars and particularly in considerations of the stellar densities in various parts of the galactic system. In fact, the hypothesis that light extinction is imperceptible is prerequisite to the conclusion that the stellar universe is finite in extent.

Because of the importance of the subject several extensive investigations have been undertaken in recent years for the purpose of determining the amount of absorption. It is generally assumed that if any dimming of a star occurs it will be apparent as selective molecular scattering, which varies as the inverse fourth power of the wave length of the light.

As the effect for blue light would be about double that for yellow, an obvious method of detecting and measuring selective absorption is through the study of the colors of faint and distant stars. By means of measures of color indices various investigators have found that the fainter stars are on the average redder than the brighter ones, and as the fainter stars are also on the average, the more distant, this excess of redness might be and often is accepted as an indication of space absorption. There are, however, other possible interpretations, including the effect of